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Investing in Science and Technology to Meet Africa's Maritime Security Challenges

By Augustus Vogel

- **The African maritime security challenge is defined by the need to monitor wide geographic expanses with limited resources.**
- **Science and technology are invaluable maritime security force multipliers.**
- **Investment in "technology" without support for "science" is unsustainable.**
- **Complementary investments in African research institutions are needed to create collaborative "anchors" to sustain the effectiveness of maritime security efforts.**

HIGHLIGHTS

Africa's long and beautiful coasts and the abundance of marine resources can contribute to providing economic, food and environmental security for the continent. These coastal and marine resources, like the rest of Africa's environmental resources, continue to be exploited in a manner that does not benefit Africa and her people. This is a paradox of a people dying from hunger, starvation and poverty when they are potentially so rich and well endowed.

—Nelson Mandela

THE MARITIME SECURITY CHALLENGE

Africa's maritime spaces host a growing number of threats that challenge both Africa and the global community. Narcotraffickers now move an estimated 50–60 tons of cocaine every year through West Africa to Europe.[1] More than 1,000 hostages were seized in 218 piracy attacks off of East Africa in 2010—double the number of incidents in 2008.[2] Armed robberies of local and international vessels in Nigerian waters continue to be a challenge and analysts expect increasing numbers of kidnappings at sea in 2011.[3] Illegal, unregulated, and unreported (IUU) fishing is estimated to cost sub-Saharan Africa about $1 billion annually,[4] the catch from which floods international markets, depresses prices, and discourages legal and environmentally sustainable practices around the world. Attacks on the oil sector in Nigeria have cost

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billions of dollars in lost revenue and repairs, helped destabilize prices globally, and contributed to an environmental disaster along Nigeria's coast caused by 546 million gallons of spilled oil.[5] Storm fronts and hurricanes such as Isabel (2003), Ivan (2004), Katrina (2005), and Ike (2008) have caused extensive flooding and the sinking of hundreds of marine craft in Africa and billions of dollars in damage in the Caribbean and North America. Moreover, Africa's $1 trillion per annum maritime economy (representing 90 percent of African commerce) is infested with illegal trafficking. This includes a multibillion dollar black market in military arms, illegally logged forest products that represent as much as 70 percent of African timber harvests,[6] and counterfeit medications that account for up to 50 percent of all sales on the African continent.[7]

There are a number of major reasons why Africa struggles to meet these maritime security challenges. First, exclusive economic zones (EEZs), which reach out 200 nautical miles from a coastline, are by definition large and difficult to monitor. This situation is exacerbated in Africa because of resource limitations. Off of West and Central Africa, for example, there are fewer than 25 maritime craft longer than 25 meters available for interdiction efforts. Many African countries, moreover, have prioritized investment in land-based forces over maritime units, thereby rendering any surveillance beyond coastal observation all but impossible. Lastly, maritime policing and management are never performed by a single agency but instead require a level of interministerial coordination and collaboration that is often difficult to achieve.[8]

SCIENCE AND TECHNOLOGY AS A SOLUTION

Strategic investment in science and technology (S&T) offers a solution to help overcome these resource constraints. Technology such as sensor networks can cover large areas with high repetition rates, collect information at a fraction of the cost of direct observation, and provide raw data in such a way that facilitates the partnerships and collaborations needed to achieve maritime security.

For instance, an array of Automatic Identification System (AIS) towers is a comparatively cost-effective means of expanding surveillance and domain control. This system allows countries to identify and monitor commercial vessels within about 20 nautical miles from the coast. Such a system would only cost the Republic of Ghana, for example, around $85,000 in start-up costs. Maintenance and operation, excluding the cost of personnel, would run on the order of $15–20,000 per annum. Although AIS does not produce a complete surveillance picture because not all ships carry transponders and towers are limited by line of sight, it is much cheaper than relying solely on patrol boats, whose operating costs run into the thousands of dollars per day.

"strategic investment in science and technology offers a solution to overcome resource constraints"

Ocean drogues are another example. These floating buoys collect oceanographic data such as salinity, temperature, and current direction. Over 3,000 "Argo floats" (one type of drogue) are operating autonomously around the globe (including African waters) at any one time. When compared to ship-based efforts, Argo floats produce more than 10 times as much data, and do so in a way that is more evenly distributed and precise. An Argo float also costs about $15,000 and can normally operate for 2 to 5 years, whereas a single day of operating a research vessel costs between $15,000 and $40,000.

These sensor networks can provide critical data for African maritime security. AIS data, for example, can help track vessels suspected of carrying illegal goods such as weapons or stolen oil, as well as monitor large "reefer" vessels that transship illegally-caught fish. Oceanographic and environmental data are also useful for monitoring and predicting movement of fish stocks (locating possible illegal fishing activity), oil spill behavior, dangerous

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weather patterns, ocean conditions for operational forces, and potential landing sites for narcotics dumped at sea.

S&T INVESTMENT IN AFRICAN MARITIME SECURITY

Experience has shown that technological investment in Africa can be successful. Cell phone technology, for example, has helped the region leapfrog landline infrastructure obstacles, dramatically improving information accessibility in a matter of years.[9] Similarly, satellite imagery now tracks land use and environmental degradation in remote parts of the continent while computers with battery-charging hand cranks support children's education in resource-poor areas.

Technology can also be a powerful tool for maritime security in Africa. But it is not sufficient. Concurrent investment in the science half of "science and technology" is essential if the benefits of technology are to be fully realized and sustained. Without it, there is no one to manage the installed technology and analyze the data generated. As a result, the limit of the equipment's functionality is typically met on the first day of operation. In the 10–15 cases where AIS towers have been installed in Africa, for example, international partners must provide even basic repairs. Moreover, African governments have rarely linked the towers through the Internet to develop a comprehensive operating picture—the ultimate aim of this surveillance network. Likewise, most tide gauges in Africa, despite their relatively low cost and ease of maintenance, are broken and unused.

A lack of "repair culture" is usually blamed for this state of affairs, despite contradictory evidence that Africans are everyday repairing other sophisticated equipment such as cars, televisions, and personal computers. The problem is more correctly one of institutional incentives. Most African governments focus spending on front-line operations such as those directly responsible for ship-based patrolling, and have not established research and development units that prioritize issues related to repair strategies, technological development, and long-term maintenance. Likewise, international partners typically donate or sell security equipment to Africa in a piecemeal fashion with only perfunctory training in operation and repair. Critically absent is support for locally-driven technological adaptation.

INTEGRATING SCIENCE WITH TECHNOLOGY THROUGH ACADEMIA

To fuse science with technology and enhance maritime security, African governments must tap an underutilized resource: African universities and research centers. Though many of these are primarily teaching colleges, talented research faculty in selected departments or science institutions can be found performing research that is relevant to maritime security and could engender mutually beneficial partnerships. Ghana, for example, has the Kwame Nkrumah University of Science and Technology, as well as departments of physics, mathematics, and oceanography and fisheries on the University of Ghana's Legon campus. Specialists in fields like atmospheric science and alternative energy can be found in Senegal's Université Cheikh Anta Diop. Mauritius has oceanographers at the Mauritius Oceanography Institute, as does Tanzania at the University of Dar es Salaam. Nigeria has oceanographers and remote sensing specialists at the University of Lagos and the Nigerian Institute for Oceanographic and Marine Research. And South Africa supports work on surveillance networks and remote ship identification through its Council for Scientific and Industrial Research.

Collaborating with African researchers provides a variety of critical advantages for ensuring sustainability of S&T investments in maritime security. First, unlike members of the military, researchers tend to be fairly settled in their specific areas of focus. They can therefore *anchor* projects by providing the continuity required to sustain strong partnerships, track technological advances, and keep programs up-to-date. This is especially important for S&T projects, given the increasing pace and sophistication of global advancements. Without scientists' involvement, African militaries will depend on external partners to manage both the technology and the program, an unfortunately common pattern of ineffective implementation and unsustainable capacity-building.

Second, independent research institutions can be a magnet for *financial resources*. Scientists bring cred-

ibility and the prospect for long-term institutional relationship-building in the eyes of external investors and donors. Research institutions, moreover, are one of the few places where military and civilian funding mingle relatively easily, providing a location where the diverse partnerships needed for maritime security can grow. It is in a research institution, for example, where oceanographic and maritime surveillance data could be fused, supporting both civilian and military objectives. An organization that manages diverse funding sources also has a higher likelihood of sustaining support for a program after the initial investment has finished.

Third, scientists are *tech-savvy*. Researchers will, for example, have fluency in the computer coding languages needed to use and adapt sensor networks or remote-controlled vehicles. They also already have training in the physics, math, and engineering needed to assimilate and adapt new systems to local conditions.

Fourth, given their advanced education, African researchers are in a position to provide *leadership* for an S&T project. They can draw on their exposure to the international community and help their governments decide how to manage S&T to enhance maritime security. Beyond having a good eye for the long-term financial consequences of investing in a technology, African researchers can also be expected to prioritize the benefits to Africa.

Fifth, African researchers tend to be deeply committed to their countries. Most have traveled abroad, yet have not used the opportunity to emigrate. At the University of Ghana's Department of Oceanography and Fisheries, for example, 73 percent of the faculty have studied abroad yet have returned to work in Ghana. This is no small issue in Africa, where "brain drain" greatly hampers development. Large investments have been wasted educating doctors and other skilled professionals who promptly left to practice outside of Africa. Involving patriotic professionals and scientists can greatly benefit the tone and direction of African maritime security efforts, especially when considering the long-term objectives of security investments.

EMERGING CASES OF MARITIME SECURITY COLLABORATION WITH ACADEMIA

Despite the benefits listed above, incorporation of academia into maritime security is not a "turn-key" solution for sustainability. Researchers must have support to build some of the very specific skills needed to develop S&T investments in maritime security. This is a challenge, given that only South Africa has had success developing a dedicated government institution for funding research. There are, however, a number of pioneering examples of promising collaborations where academic institutions work as S&T anchors for maritime security in Africa. They underscore the fact that maritime security is a complex issue that will not be solved by singular actions such as putting more boats on the water. Rather, partnership and comprehensive intersectoral coordination are imperative.

Coastal processes and maritime domain awareness in Ghana. In 2008, a relationship was initiated between the U.S. Navy's Office of Naval Research (ONR) and the University of Ghana's Department of Oceanography and Fisheries (UGDOF) to develop a mutually beneficial coastal geosciences program. For ONR, the program produces research relevant to its coastal sciences program. For Ghana, the research support is being used to understand persistent coastal erosion of 1–2 meters/year that it is washing away towns, highways (the West African Highway between Abidjan and Lagos is nearly cut), and coastal infrastructure.

Findings from the research also contribute to Ghanaian maritime security. Analyses of erosion rates, information on sea state (like dangerous wave heights and directions), and ocean processes such as currents or temperature patterns that attract illegal fishing help the Ghanaian Navy better manage coastal bases and support coastal patrols searching for traffickers.

This collaboration is further maturing to include U.S. Naval Forces Africa's Africa Partnership Station (APS). This partnership is helping UGDOF leverage its remote sensing center, initially created for research on coastal environmental processes, to develop more advanced sensor tools for maritime security. Satellite imagery is being integrated with other sensor networks (such as AIS) to monitor ship traffic and analyze maritime activity off Ghana relevant to oil spill management, fishing, commercial activity, and patterns of and threats to port traffic. Through the partnership, Ghanaian researchers are developing skills and technologies that enhance UGDOF's reputation as a leading center of maritime expertise. They are

also helping Ghana's maritime security forces cover its 235,000-square-kilometer EEZ in a far more cost-efficient manner than it could by patrolling alone.

Meteorology, oceanography, and hydrography in West Africa. Another partnership that is benefiting maritime security is a program to engage scientists across Africa in topics related to meteorology, oceanography, and hydrography. Although many navies around the

> **"[support to African scientists is] fostering a deeper understanding of offshore activities in Africa"**

globe have departments dedicated to collecting these types of environmental information, this is not the norm in Africa. African research institutions are therefore in a position to develop the products and maps that support this initial critical piece to maritime domain awareness—namely the baseline data that describe the environment in which maritime security forces operate.

Training and collaboration are occurring among institutions from the United States, Europe, and Africa and are focused on analyzing data collected from sensor networks. Over 115 ocean drogues (supplied by the U.S. National Oceanic and Atmospheric Administration) have been deployed around Africa since 2008. A related deployment of meteorological sensors across coastal West and Central Africa will be completed in 2011. To incorporate the science for managing these sensors, international workshops in Senegal, Nigeria, and Ghana (with plans for Gabon) have focused on ocean data analysis and creating maritime weather forecasts. Nigerian scientists, moreover, have benefited from formal education programs in hydrography in the United States.

African nations will use these sensor data and training to better predict weather formations that kill innumerable African mariners every year, understand ocean currents for managing oil spills, and create bathymetric charts that are invaluable for the safety of maritime security operations. As in Ghana, researchers are collaborating with maritime security forces to deploy comprehensive sensor networks at modest costs. In the process, they are fostering partnerships that promote a deeper understanding of offshore activities in Africa.

Sensor development and remote monitoring in South Africa. South Africa has the most sophisticated program for leveraging civilian research to the benefit of national security. Much of it is centered in the Council for Scientific and Industrial Research (CSIR). CSIR embodies an effort to build a scientific community that is tech-savvy, capable of supporting research beneficial to both civilian and military interests, durable and leadership-ready, and committed to building a strong South Africa.

Efforts at CSIR speak directly to maritime security and the challenges faced by Africa. Environmental data are being collected by CSIR's Earth Observation department, research on optics for naval patrol vessels is being advanced, sensor networks and unmanned vehicles are being built, and analyses of maritime vessel identification from space are being carried out. Instead of leaving operational security forces to deal with technology on their own, CSIR is providing the scientific partnership needed to comprehensively and efficiently monitor South Africa's waters.

RECOMMENDATIONS

The scope for expanding the use of S&T to enhance maritime security in Africa is substantial. Priority areas of focus include the following:

Assess viability of comprehensive maritime domain awareness strategies in Africa. The African Union and its respective subregional bodies have been increasingly focused on the importance of maritime security. A vital foundational effort should be an analysis of what it would take, both logistically and financially, to have a reasonable level of maritime domain awareness in African waters. The study would need to identify what types of data should be collected, how they would be collected, and the advantages of different technology strategies. This effort, in which African scientists would play a leading role, would provide the African Union a tangible starting point for assessing the most cost-effective strategies for monitoring Africa's waters for illegal activity. The engagement of African researchers in this process could likewise jumpstart opportunities for collaboration across a wide variety of maritime security issues.

Include research cells in maritime security efforts. Wherever there is an investment in maritime

security, sustainability must be a critical consideration. When that investment includes technology, maritime security forces should collaborate with research groups to meet that requirement. This will augment both the longevity and the adaptability of the technology. A research cell could also help ensure technology provided by external partners was compatible with pre-existing equipment in the operating environment.

Invest in S&T areas where African research expertise already exists. African research and maritime security efforts are currently poorly coordinated. However, a program that attempted to impose a general realignment would likely fail because of high costs and wariness of militarization. Instead, S&T investment for maritime security should be directed to where local expertise in the civilian research community currently exists. Three potential topics include cost-efficient communication technology, ocean sensor networks, and alternative energy. For communication technology, various programs are already developing tools to help artisanal fisherman communicate from their canoes, presenting an opportunity to put more eyes on the water. Likewise, many African universities have initiated efforts to enhance their ocean sensor networks, particularly those based on satellite technology. With alternative energy, engaging civilian researchers involved in the substantial biofuel investment in Africa could have far-reaching pay-offs for the many African maritime security forces that have highly constrained fuel budgets. In short, there is no need to reinvent the wheel. Targeted support can scale-up already proven successes.

These recommendations build on the goal of enhancing maritime security through deployment of cost-effective sensor networks and collaborative use of data. They reflect a belief that technology is an essential function of covering the expansiveness of Africa's maritime domain. This potential, however, is ultimately dependent on the engagement and support of African researchers to provide the science for making these investments sustainable.

NOTES

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